



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

PUBLIC HEALTH REPORTS.

VOL. XXV.

JULY 29, 1910.

No. 30.

A CORRECTION.

The reference to Doctor Fraser's work on beriberi on page 922 of the Public Health Reports of July 1 should have read Medical Record, April 30, 1910, page 762, instead of New York Medical Journal. The account of Doctor Fraser's paper appeared in the report of the meeting of the Far Eastern Association of Tropical Medicine in the Medical Record.

NOTES ON AGENTS USED FOR FLEA DESTRUCTION.

By MAURICE B. MITZMAIN, M. S., Assistant, Plague Laboratory, Public Health and Marine-Hospital Service, San Francisco, Cal.

This report is essentially a preliminary one based on a study of a few of the common germicides, some insecticides, and several other substances. No effort was made to test exhaustively any one of the agents used, and the study was conducted from the standpoint of the biological interest rather than that of the economical.

The investigation was undertaken primarily for the purpose of determining the efficiency of the solutions used in the laboratory for dipping rodents sent in for examination. The main object of the dipping is the killing of fleas and other ectoparasites that are found on the rodents. Lack of time has prevented a thorough investigation of the field, but such results as we have obtained are set forth here.

In the early part of the plague campaign, various agents were utilized for the purpose of destroying parasites on rodents. Mercuric chloride in the strength ordinarily used for disinfection—that is, 1 part to 1,000 of water—was extensively employed; 5 per cent carbolic acid was also used.

MODE IN WHICH INSECTS ARE DESTROYED.

For the purpose of the present work, we may say that insects are killed by the agents under discussion in one of the three following ways:

(a) *Chemical agents*.—A corroding of the tissue due to chemical action.
(b) *Physical agents*.—The stoppage of the spiracles, causing suffocation.

(c) *Physiological agents*.—The effects on the nervous system, such as are produced by chloroform and ether. These latter agents will not be discussed in detail in this paper, except to state that it is well known that both of them very promptly affect these insects. Paralysis is evident after a short time, and if the anesthetic is continued long enough the insect is killed.

We have found in the case of rats, squirrels, and guinea pigs that the fleas do not recover from the effects of an anesthetic (ether or chloroform) synchronously with the host, and in many instances fleas recover from the administration of ether or chloroform when the

host succumbs. On the other hand, when a moderate amount of an anesthetic is given, we have found that the host invariably recovers long before the fleas do.

TECHNIQUE.

As indicated in the tables, the technique employed consisted in some cases in placing the fleas momentarily in the liquid, then returning them to a dry vial; in others, complete submersion, that is, by the exclusion of air; or again by letting the insect float on the surface of the liquid. In the case of gaseous agents and insect powders special methods applicable to the respective agents were used.

In the matter of the criterion of death the test applied was absence of movement for half an hour or more. In many instances the insect was at first apparently killed, but recovered sufficiently to perform its functions, including biting. In other words, it is often impossible to say that a flea is dead, unless the observation covers a considerable length of time.

The following species of fleas were used in our experiments:

Pulex irritans Linn, taken from human hosts and from rodents.

Ceratophyllus fasciatus Bosc. and *Loemopsylla cheopis* Roth., taken from rats.

Hoplopyllus anomalus Baker and *Ceratophyllus acutus* Baker, taken from squirrels.

It was impracticable to determine the relative resistance of the different species to the agents used. Varying lengths of time elapsed after the removal of the flea from the host, and no cognizance is taken of the condition of starvation of the parasites—a point which may be of some moment. Care was taken, however, that the insects were sufficiently healthy to hop about freely.

It would of course have been more satisfactory to have determined exactly by chemical tests the composition of the various agents used and by accurate observation the meteorological conditions involved in the use of each of the agents, but this is scarcely practicable in the actual application of these agents. It is well known that in using a disinfectant or a germicide a large margin of safety must be allowed; that is to say, the strength used should be much greater than the minimum required to kill the germ or the insect.

The technique used is stated in each table.

Several agents which were regarded as more or less inert were used with the intention of determining the effect of their physical influence on the fleas. For instance, tap water, as is shown by the following table, had practically no influence on fleas unless air was excluded; in other words, it was almost impossible to drown these insects by dropping them in water.

Glycerine was also used.

Agent applied; strength used.	Species and number of specimens.	Technique	Result.
Tap water.....	15 <i>C. acutus</i>	Insects placed in water in open test tube and left to swim about undisturbed.	1 dead in 24 hours; others alive from 1 to 7 days.
Do.....	3 <i>C. acutus</i>	Insects submerged in cell slides, air excluded with cover slips.	Movement ceased in 5 to 10 minutes; dead in 30 minutes.
Glycerine equivalent to 50 per cent equal parts (by volume) of glycerine and water.	do.....	Placed in liquid in open test tube.	1 specimen alive after 4 hours; 2 specimens alive after 8 hours.
.....	4 <i>C. acutus</i>	Left in liquid over night....	Dead following morning.

Tincture of green soap.—It was rather surprising to observe the effect that this agent exerted. Although it is known that it has some power as a germicide, we were scarcely prepared to find it so promptly fatal to fleas. As this agent contains some alcohol, the latter agent was tested separately.

Agent applied, strength used.	Species and number of specimens.	Technique.	Result.
Tincture of green soap..	1 <i>C. acutus</i>	Insect dipped entirely in the liquid, then placed in open cell slides.	Dead in 2 minutes.
Do.....	do.....	do.....	Movement ceased in 40 seconds; dead in 2½ minutes.
Do.....	do.....	do.....	Movement ceased in 25 seconds; dead in 10 minutes.
Do.....	do.....	Cell slide; air excluded by use of cover slip.	Movement ceased in 50 seconds; dead in 3 minutes.
Do.....	1 <i>P. irritans</i> ...	Placed in open cell slide.....	No motion in 50 seconds; dead in 2 minutes.
Alcohol absolute.....	5 <i>C. acutus</i>	do.....	Movement ceased in 20 to 55 seconds; all recovered.
Do.....	2 <i>C. acutus</i>	Insects placed in cell slide; air excluded with cover slip.	No movement in 55 seconds; dead in 2 minutes.
Do.....	6 <i>C. acutus</i>	Left to swim in open test tube.	All dead in 7 minutes.

The agents mentioned in the next table all enjoy considerable reputation as insecticides. Water was used for making the dilutions or mechanical mixtures.

Agent applied; strength used.	Species and number of specimens.	Technique.	Result.
Oil of pennyroyal (pure)..	5 <i>C. acutus</i>	Insects left in liquid in watch glass.	Movement ceased in 15 to 20 seconds; dead in 1 minute 20 seconds to 5 minutes.
Oil of peppermint, 1 to 50 of water.	3 <i>C. acutus</i> ..	do.....	Movement ceased in 20 to 22 seconds; dead in 2 minutes.
Do.....	do.....	do.....	Movement ceased in 15 to 20 seconds; dead in 2 minutes to 4 minutes 30 seconds.
Kerosene (full strength)...	2 <i>C. acutus</i>	Flea submerged in liquid momentarily and placed on clean slide.	No movement in 10 to 20 seconds; dead in 30 seconds.
Do.....	4 <i>C. acutus</i>	Left to swim in liquid in cell slide.	Movement ceased in 18 to 35 seconds; dead in 9 to 10 minutes.
Do.....	2 <i>C. acutus</i>	Submerged in covered cell slide for 15 seconds; placed on clean slide.	Dead in 20 seconds.
Kerosene, 1 to 20 of water..	5 <i>C. acutus</i>	Left to swim in liquid in cell slide.	Dead in 11 to 15 minutes.
"Miscible oil" (potash soap, 40 per cent, made from whale oil, and mixed with kerosene; contains 60 per cent of the latter).	do.....	Fleas dipped in the liquid momentarily, then exposed to air on clean slide.	Movement ceased in 17 to 20 seconds; dead in 3 to 10 minutes.
Do.....	do.....	do.....	Movement ceased in 15 to 23 seconds; death resulted in 2 to 5 minutes.

The germicides proper were in the strength ordinarily employed in disinfection; they were diluted with water. In the strengths used all were efficient in killing the nonspore-bearing bacteria, at least a majority of these organisms being devitalized within a minute. It should be stated here that the question of the killing of the insect is entirely aside from that of the destruction of the pathogenic micro-organisms that may be encased in the body.

The refuse from the Pintsch gas tanks was suggested for use by Passed Asst. Surg. W. C. Rucker, and a few experiments were carried

out with this agent. Its chemical composition is not known to us, and it is presumed that the composition is not constant. It was thought that this might afford a cheap and efficient insecticide. This agent is used in some parts of the State as a squirrel exterminator.

Agent applied; strength used.	Species and number of specimens.	Technique.	Result.
Formalin, ^a 1 to 1,000....	1 <i>C. acutus</i>	Placed in cell slide with liquid, air excluded.	No movement after 10 seconds; dead in 10 minutes.
Do.....	3 <i>C. acutus</i>	Left to swim in liquid in the watch glass.	Apparently dead in 12 hours; revived.
Formalin, 1 to 100.....	1 <i>P. irritans</i>	do.....	Movement ceased in 38 min- utes; dead in 44 minutes.
Formalin, 1 to 20.....	1 <i>C. acutus</i>	do.....	Movement ceased in 3 minutes; dead in 1 hour 40 minutes.
Formalin, 1 to 10.....	1 <i>P. irritans</i>	do.....	Movement ceased in 1 minute 40 seconds; dead in 5 minutes.
Pure formalin.....	2 <i>P. irritans</i>	do.....	Movement ceased in 1 to 3 min- utes; dead in 5 to 6 minutes.
70 per cent creosote, re- mainder soap and water.	1 <i>C. fasciatus</i>	Kept 20 minutes in liquid.....	No movement in 3 minutes; alive after 15 minutes; dead in 20 minutes.
Do.....	do.....	Kept 10 minutes in liquid.....	No movement in 1 minute 30 seconds; dead in 10 minutes.
Do.....	do.....	Kept in liquid 12 minutes.....	No movement in 2 minutes; dead in 13 minutes.
Do.....	do.....	Permitted to swim in open cell slide.	
Phenol, 1 per cent.....	2 <i>L. cheopis</i>	Left swimming in liquid on watch glass; then placed on clean slide after apparent death.	No movement in 19 minutes 30 seconds; dead in 35 minutes.
Phenol, 5 per cent.....	do.....	do.....	Movement ceased in 6 minutes; dead in 12 minutes.
Phenol, about 25 per cent.	do.....	do.....	Movement ceased in 45 seconds; dead in 3 minutes.
Phenol, 100 per cent....	do.....	do.....	Movement ceased in 22 seconds; dead in 1 minute 5 seconds.

^a "Formalin" means a solution that is said to contain 40 per cent of formaldehyde.

Agent applied; strength used.	Species and number of specimens.	Technique.	Result.
Mercuric chloride, 1 to 1,000.	2 <i>C. acutus</i>	Allowed to swim in liquid in cell slide.	1 specimen alive after 10 hours. 1 specimen alive after 18 hours; both dead next morn- ing.
Do.....	4 <i>C. acutus</i>	Submerged in cell slide; air excluded by cover slip.	Dead in 10 to 12 minutes.
Chloro-naphtholeum, 1 to 50.	5 <i>C. acutus</i>	Immersed in liquid until mo- tion ceased.	1 specimen paralyzed in 25 sec- onds; recovered in 1 minute. 1 specimen ceased movement in 4 minutes; recovered. 2 specimens ceased movement in 5 minutes; recovered. 1 specimen dead in 24 hours.
"Hyco," 1 to 100.....	4 <i>C. fasciatus</i>	Left swimming in liquid in open tube.	Movement ceased in 3 minutes; 8 minutes; alive after 40 min- utes; recovered when re- moved from liquid.
"Hyco," 1 to 50.....	1 <i>C. fasciatus</i>	Left in liquid until movement ceased; placed on slide.	Recovered after 20 minutes in liquid.
"Hyco" 1 to 50.....	2 <i>C. fasciatus</i>	do.....	Movement ceased in 1 to 3 min- utes; recovered.
"Hyco," 100 per cent..	3 <i>C. fasciatus</i>	do.....	1 specimen dead in 4 minutes. 1 specimen dead in 1 minute. 1 specimen dead in 1 minute 30 seconds.
"Trikesol," 1 per cent.	3 <i>C. acutus</i>	Immersed momentarily in liquid in cell slide. Then exposed on glass slide.	Recovered in 8 minutes; 1 hour. 1 specimen laid 3 eggs after treatment.
Do.....	5 <i>C. acutus</i>	Submerged in liquid till death.	Dead in 45 seconds. 3 minutes.
Hydrocarbon (refuse from Pintsch gas used in railway cars).	10 <i>C. fasciatus</i>	Flea placed in test tube stop- pered with cotton plug con- taining 25 drops of agent.	No movement in 4 minutes; dead in 20 minutes.
Do.....	do.....	5 drops.....	No movement in 4 minutes; dead in 1 hour.)

Powdered sulphur is not used as a germicide, but it is frequently used as an insecticide. It was a matter of surprise as well as of interest to find it practically inert and useless for the killing of fleas.

Thymol is a widely used anthelmintic, and it was thought worth while to perform an experiment with this agent.

Chloride of lime is extensively used as a deodorant and a disinfectant. Just how efficient it is as a disinfectant varies greatly with the sample employed.

Agent used, strength applied.	Species and number of specimens.	Technique.	Result.
Powdered sulphur....	2 <i>C. fasciatus</i>	Powder placed in tube and fleas covered with it.	Fleas alive after 20 hours.
Do.....	10 <i>C. fasciatus</i>	do.....	Fleas alive after 20 hours; still alive after 2 days.
California insect powder, known also as pyrethrum and Persian insect powder.	7 <i>C. acutus</i>	Powder placed in test tube with fleas; tubes shaken so as to surround the fleas with the powder.	All dead next morning.
Do.....	5 <i>C. fasciatus</i>	do.....	All barely alive next morning.
Chloride of lime, commercial, 1 pound; 2 gallons of water.	3 <i>C. acutus</i>	Left to swim in liquid in cell slide.	1 specimen ceased movement in 10 minutes; dead in 30 minutes. 1 specimen dead in 1 hour. 1 specimen dead in 17 minutes.
Do.....	13 <i>C. acutus</i>	Immersed momentarily in liquid. Then placed in dry vial.	Dead next morning.

Carbon bisulfid is widely employed for the killing of rodents, being placed in the burrows on cotton or waste. In sufficient strength, it is an efficient agent for killing fleas.

Agent applied; strength used.	Species and number of specimens.	Technique.	Result.
Carbon bisulfid.....	4 <i>C. acutus</i>	Insects dipped in liquid and placed on dry slides.	Dead in 25 seconds.
Do.....	8 <i>C. acutus</i>	1 drop of carbon bisulfid on cotton plug. ^a	Recovered after exposure to gas for 30 to 45 minutes.
Do.....	10 <i>C. acutus</i>	2 drops of carbon bisulfid on cotton plug. ^a	Apparent death in 25 minutes; recovered.
Do.....	3 <i>C. acutus</i>	3 drops carbon bisulfid on cotton plug. ^a	Dead in 1 hour 8 minutes.
Do.....	2 <i>C. acutus</i>	4 drops carbon bisulfid on cotton plug. ^a	No movement in 2 minutes; dead in 7 minutes.
Do.....	3 <i>C. acutus</i>	5 drops carbon bisulfid on cotton plug. ^a	No movement in 1 minute 15 seconds; dead in 5 to 12 minutes.

^a Drops of agent placed on cotton plug in test tube. Insects exposed to fumes.

Several fumigation experiments were carried out with formaldehyde.

Sulphur fumigation should have received more extensive consideration, but on account of press of routine work we were unable to give it the time and attention it deserved at the time these experiments were conducted.

Fumigation with hydrocyanic gas is commonly practiced in the citrus orchards of California. This agent is occasionally employed in the strength we have applied for house insect pests, including fleas.

Reagent.	How evolved.	Container or animal used.	Fleas used.	Exposure.	Results.
Formaldehyde:					
Experiment 1a.	Permanganate method 1,200 cc. Formalin 2,000 cubic feet air space.	Open beaker	16 <i>C. acutus</i>	16 hours.....	14 fleas killed, 2 alive.
Experiment 1b.	{ Same method 3,000 cc. Formalin 2,000 cubic feet.	{ 4 thicknesses of toweling.	{ 12 <i>C. acutus</i>	{ 3½ hours..... 4 hours.....	{ 1 flea alive. All killed.
Experiment 1c.	{ Same method 1,000 cc. Formalin 2,000 cubic feet.	{ 312-gram brown rat in wire cage.	{ 5 <i>C. fasciatus</i> do.....	{ 8 hours..... 9½ hours.....	{ Rat alive. Rat and fleas killed.
Hydrocyanic acid gas:					
Experiment 2a.	1 ounce KCN. By weight, 1 ounce HSO; by volume 2½ ounces. Water by volume 100 cubic feet air space.	4 thicknesses of toweling.	<i>C. acutus</i> (5 adults, 5 larvæ).	45 minutes..	5 larvæ dead, 1 adult alive, 4 adults alive.
Experiment 2b.	do.....	Open beaker	<i>C. acutus</i> (10 larvæ).	30 minutes..	All killed.
Experiment 2c.	{ do.....	{ do.....	{ 15 <i>C. acutus</i>	{ 30 minutes.. 45 minutes.. 30 minutes.. 45 minutes.. 30 minutes.. 50 minutes.. 1 hour 20 minutes..	{ Alive. All killed. Alive, 1 disabled. All dead. Alive. 3 fleas dead. All dead.
Experiment 2d.	{ do.....	{ do.....	{ 10 <i>C. acutus</i>	{ 30 minutes.. 45 minutes.. 30 minutes.. 50 minutes.. 1 hour 20 minutes..	{ Alive. All dead. Alive. 3 fleas dead. All dead.
Experiment 2e.	{ do.....	{ 4 thicknesses of toweling.	{ do.....	{ 30 minutes.. 45 minutes.. 30 minutes.. 50 minutes.. 1 hour 20 minutes..	{ Alive. All dead. Alive. 3 fleas dead. All dead.
Experiment 2f.	{ do.....	{ 312-gram brown rat in wire cage.	{ 10 <i>C. fasciatus</i>	{ 15 minutes.. 20 minutes.. 12 minutes..	{ Rat alive. Rat alive, fleas alive. Rat dead, fleas alive.
Experiment 2g.	1 ounce KCN. By weight, 1 ounce HSO; by volume, 2½ ounces. Water by volume, 100 cubic feet air space.	142 grams brown rat in wire cage.	5 <i>C. acutus</i>	12 minutes..	Rat dead, fleas alive.
Carbon bisulphid:					
Experiment 3a.	By evaporation, 4 c.c. 1 cubic foot.	Open beaker	10 <i>C. fasciatus</i> ...	2 hours.....	All dead.
Experiment 3b.	do.....	4 thicknesses of toweling.	<i>C. fasciatus</i> (10 adults, 10 larvæ).	do.....	Adults survived, larvæ killed.
Experiment 3c.	do.....	113 grams brown rat in wire cage.	5 <i>C. acutus</i> , 5 <i>H. anomalus</i> .	do.....	Rat dead, fleas alive.
Experiment 3d.	do.....	85 grams brown rat in wire cage.	6 <i>C. acutus</i>	1½ hours.....	Rat dead, fleas alive.
Sulphur:					
Experiment 4a.	SO ² by burning 2 pounds, 100 cubic feet.	4 thicknesses of toweling.	12 <i>C. acutus</i>	4 hours.....	Not affected.
Experiment 4b.	SO ² by burning 1 pound, 100 cubic feet.	Open beaker	10 <i>C. acutus</i>	12 hours.....	All dead.
Experiment 4c.	Burning sulphur cones, 4½ ounces, 100 cubic feet.	do.....	<i>C. acutus</i> (10 adults, 6 larvæ).	4½ hours.....	Do.
Experiment 4d.	do.....	4 thicknesses.	10 <i>C. acutus</i>	do.....	Fleas dead.
Experiment 4e.	Burning sulphur cones, 8½ ounces, 100 cubic feet.	Open beaker	do.....	1½ hours.....	Do.
Experiment 4f.	do.....	170 grams brown rat in wire cage.	do.....	20 minutes..	Rat and fleas dead.
Experiment 4g.	do.....	240 grams brown rat in wire cage.	7 <i>C. acutus</i>	25 minutes..	Do.

SUMMARY.

Water is of little value in the destruction of fleas.

Glycerine is practically inert as a pulicid.

Alcohol in the strength of 70 per cent and absolute is uncertain in its action and practically inefficient.

Kerosene and miscible oil are extremely efficient as flea destroyers.

Formalin, phenol, mercuric chloride and trikresol in the strengths used as disinfectants are of little value in killing fleas.

Powdered sulphur proved of no value.

The fumigants bisulfid of carbon, hydrocyanic acid gas, and sulphur dioxid are highly efficient in the strengths employed for flea destruction.